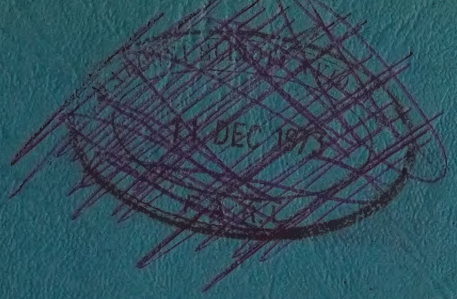
TF 2151 & 2152

356



TF 2151 & TF 2152

Power Supply

INSTRUCTION MANUAL

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MARCONI INSTRUMENTS

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INSTRUCTION MANUAL
No. EB 2151 & 2152

for

Power Supply
TF 2151 & TF 2152

Contents

Chapter 1 GENERAL INFORMATION

1.1 Introduction 5
1.2 Data Summary 5

Chapter 2 OPERATION

2.1 Installation 7
2.2 Power Supply 7
2.2.1 Transformer tapping 7
2.2.2 Access 7
2.2.3 Mains Plug connection 7
2.2.4 Fuse replacement 8
2.3 Controls and Connectors 8
2.4 Operating Procedure 9
2.5 Series and Parallel connected 10
2.6 Remote Sensing facility 10

Chapter 3 TECHNICAL DESCRIPTION

3.1 Introduction 11
3.2 General Description 11
3.3 Circuit Description 12

Chapter 4 MAINTENANCE and REPAIR

4.1 Introduction 14
4.2 Access and Layout 14
4.3 Re-alignment Procedure 14
4.4 Packaging for Re-shipment 16

Chapter 5 REPAIR

5.1 Introduction 17
5.2 Ordering 17
5.3 Parts List 18

CIRCUIT DIAGRAM 21

Chapter 1

General information

1.1 INTRODUCTION

The TF 2151 and TF 2152 Power Supplies are unique in that they offer in a single, light and compact unit; a choice of three modes, a coarse and fine voltage limit control, an extra large meter and a remote sensing facility.

Each unit contains two separate supplies of equal rating, one of which is regulated by comparison with the other, and can be connected to provide three possible output configurations. Thus with a 60 watts output capability, each unit provides a switchable variable high and low maximum voltage range (TF 2151 - 15 V or 30 V, TF 2152 - 30 V or 60 V) as well as the variable twin balanced output. The centre tap terminal is effective only on the higher voltage range and provides a stable centre point to the positive and negative supply rails.

In the centre tapped mode the current limit control operates on both rails if over-limit currents are drawn from either the positive or negative supply rails. Transient suppression facilities are incorporated ensuring only minimal output transients.

Output voltage is set by a dual concentric single-turn 3% calibrated potentiometer. The fine control having a total swing of 5% of the full scale and a minimum increment of better than 0.03% of the full scale over the selected range.

To safeguard circuits supplied by the unit, the calibrated voltage and current limit controls may be set at safe limits prior to switch on.

A large scale voltage/current meter having a scale length of 120 mm provides monitoring of output voltage, or positive or negative line current as selected by a three-position switch.

No change in output occurs when the meter is switched from voltage to current measurement.

The remote sensing facility is provided by extending the sensing loop, via a pair of output terminals, to the load thereby enabling long feeders to be used without degrading the regulation of the power supply.

1.2 DATA SUMMARY

Output Power		0 to 60 watts
Modes		
	TF 2151	
	(30 volt mode)	15-0-15 volts at 0 to 2 amps
		0 to 30 volts at 0 to 2 amps
	(15 volt mode)	0 to 15 volts at 0 to 4 amps
	TF 2152	
	(60 volt mode)	30-0-30 volts at 0 to 1 amp
		0 to 60 volts at 0 to 1 amp
	(30 volt mode)	0 to 30 volts at 0 to 2 amps

Minimum Voltage Increment	Less than 0.03% of full-scale
Output Impedance	0.01Ω at 1 kHz.
Isolation	The power supply circuit can be floated up to 300 volts peak with respect to its case.
Meter	
TF 2151	Scaled 0 to 4 amps and 0 to 30 volts.
TF 2152	Scaled 0 to 2 amps and 0 to 60 volts.
Accuracy	±2% full scale
Scale length	120 mm (4.2 in).
Constant Voltage	
Supply Line Regulation	Less than 0.02% of maximum output for a 10% AC change.
Load Regulation	Less than 0.05% of maximum output for a 100% load change.
Centre Tap Regulation	Less than 0.05% for a 100% load change over full range of output voltage. Tracking deviation typically ±0.1% of maximum output voltage.
Temperature Coefficient	Less than 0.02% per °C.
Ripple & Noise	Less than 1 mV p-p.
Transient Response	
TF 2151	Recovers to within 50 mV in 30 µs for full load step change.
TF 2152	Recovers to within 50 mV in 20 µs for full load step change.
Power Requirements	
A.C. Mains	110, 220, 230 or 240 volts, ±10% 48-60 Hz.

Dimensions

Height	Width	Depth	Weight
125 mm (4.9 in)	310 mm (12.2 in)	230 mm (9 in)	7 kg (15 lb)

Chapter 2

Operation

2.1 INSTALLATION

To ensure adequate cooling of the heat sinks it is important to maintain free circulation of air especially through the meshed rear section of the instrument.

CAUTION

When the units are delivering more than 50% of their maximum rated output it is essential that they are not stacked.

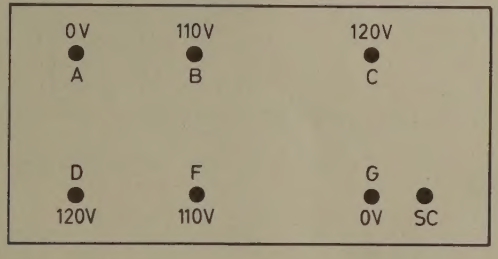
2.2 POWER SUPPLY

The units are supplied ready for use with a 240 V a.c. 50 Hz mains supply and will work satisfactorily within the specification limits of ±10%.

2.2.1 Transformer Tapping

Primary tappings are provided for line voltages of 110 V, 120 V, 220 V and 230 V a.c. when required. Table 2.1 gives the primary tap linking.

Supply	Link	L (Brown)	N (Blue)
240 V	G to C (0 to 120 V)	D (120 V)	A (0 V)
230 V	G to B (0 to 110 V)	D (120 V)	A (0 V)
220 V	G to B (0 to 110 V)	F (110 V)	A (0 V)
120 V	A to G, C to D (0 to 120 V)	D (120 V)	A (0 V)
110 V	A to G, B to F (0 to 110 V)	F (110 V)	A (0 V)



2.2.2 Access

Access to the inside of the instrument can be easily made by first removing the two 4 BA Pozidrive screws on the base securing the cover and then withdrawing the unit.

2.2.3 Mains Plug connection

A suitable mains plug must be connected to the captive power lead by the user. The three connectors are colour coded to the international standard as follows:-

BROWN	-	LIVE
BLUE	-	NEUTRAL
GREEN/YELLOW	-	EARTH

2.2.4 Fuse replacement

The fuse holder is located in the top right hand corner of the front panel. Replacement fuses are rated at 3 amps and are obtainable from our Service Division (for address see back cover).

Replacement fuse - 3 A Belling Lee L142713 Marconi
Part No. TF 2151/2152 FPP 23402

2.3 CONTROLS AND CONNECTORS

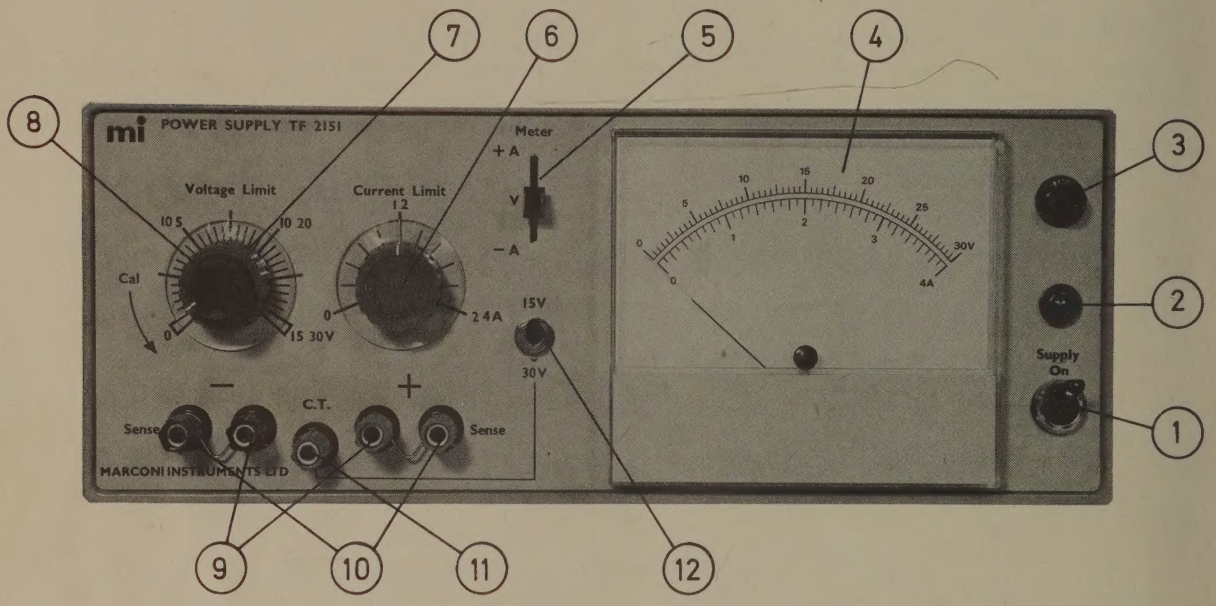


Fig. 2.1 Controls and connectors

(1) SUPPLY ON/OFF switch (SW1)

(2) SUPPLY INDICATOR lamp(LP1)

(3) FUSE (FS1) and holder. Use a 3 amp fuse.

(4) METER(M1). Monitors the output voltage and current as selected by the Meter switch.

(5) METER switch (SW3). Selects voltage or current metering range. With the centre tap connected, monitoring of either positive line current or negative line current is selectable.

(6) CURRENT LIMIT control (RV2). This control determines the maximum current that can be drawn from the output terminals.

(7) VOLTAGE LIMIT control (RV1a). This control adjusts the output voltage which is maintained until the current limits. Accuracy of calibration ±3%.

(8) VOLTAGE LIMIT fine control (RV1b). This control has a total swing of 5% of full scale and a minimum increment of 0.03% of full scale.

(9) SOURCE OUTPUT terminals (TL1, TL5). Provides a single output on either high or low voltage range.

(10) SENSE OUTPUT terminals (TL2, TL4). Provides a single output on either high or low voltage range, monitored and regulated as sensed at the load input terminals.

(11) CENTRE TAP terminal (TL3). Operational on the high voltage range only. Provides a twin output at half voltage, symmetrical about the centre tap terminal.

(12) VOLTAGE RANGE switch (SW2). Selects high or low voltage mode. High voltage markings and scale are in red.

2.4 OPERATING PROCEDURE

Before connecting the unit to the mains supply ensure that the mains transformer tapping is correctly set as outlined in Chapter 2.2.1 then proceed as follows:-

(i) Ensure the SUPPLY switch is in the OFF position.

(ii) Connect the OUTPUT TERMINALS to the load as required. The output is available as a single output at the full rated voltage or as two supplies at half voltage, symmetrically about the centre tap. When the lower voltage range is chosen the two supplies are connected in parallel and the centre tap terminal has an output impedance of 5 kΩ . When the higher voltage range is chosen, the two supplies are connected in series and the centre tap terminal is connected to the junction of the supplies. In either configuration any one of the terminals may be earthed to determine the polarity of the output.

(iii) Adjust CURRENT LIMIT control to required level. This control may be set up against the internal meter by selecting a low output voltage, short circuiting the output terminals and setting the control to the required level.

(iv) Turn the VOLTAGE LIMIT controls fully counter-clockwise. With the Voltage Limit fine control in this position the coarse control is calibrated to within ±3% of full scale.

(v) Switch the VOLTAGE RANGE switch to the appropriate position.

(vi) Switch the METER RANGE switch to the appropriate position.

(vii) Switch ON unit.

(viii) Adjust the VOLTAGE LIMIT coarse control to the required voltage. The accuracy of this control is ±3%. Greater accuracy may be obtained by setting the output voltage against the internal meter or an external digital voltmeter using the fine Voltage Limit control.

2.5 SERIES AND PARALLEL CONNECTED

By connecting several of these supplies in parallel or series it is possible to obtain extra power, multiple output rails or higher voltage levels than those already provided.

The limit imposed by the safe working voltage (300 V) controls the number of units that can be connected in series.

In the parallel configuration, current sharing may not be exact due to inaccuracies in setting up the output voltage of the supplies. However the current limiting action will ensure that none of the supplies are overloaded while the stabilising action will be maintained by the supply delivering the lowest output voltage. To ensure that the best possible load sharing is achieved fine adjustment of the voltage may be made while the supplies are driving the load.

2.6 REMOTE SENSING FACILITY

For optimum remote sensing regulation, the voltage drop along the line should be not greater than 500 mV. If long feeders are being used to deliver high currents, some oscillation along the line may be experienced. This can be reduced, in most cases to a negligable level, by de-coupling the output at the remote end of the line. The value of capacitor required is typically 10 to 20 μF.

CAUTION

When delivering power via the Source output terminals, it is essential to ensure that the shorting links across the Sense and Source terminals are connected. If they are not the voltage at the Source terminals will rise to the maximum voltage of the unit and thus endanger the load equipment.

Chapter 3

Technical description

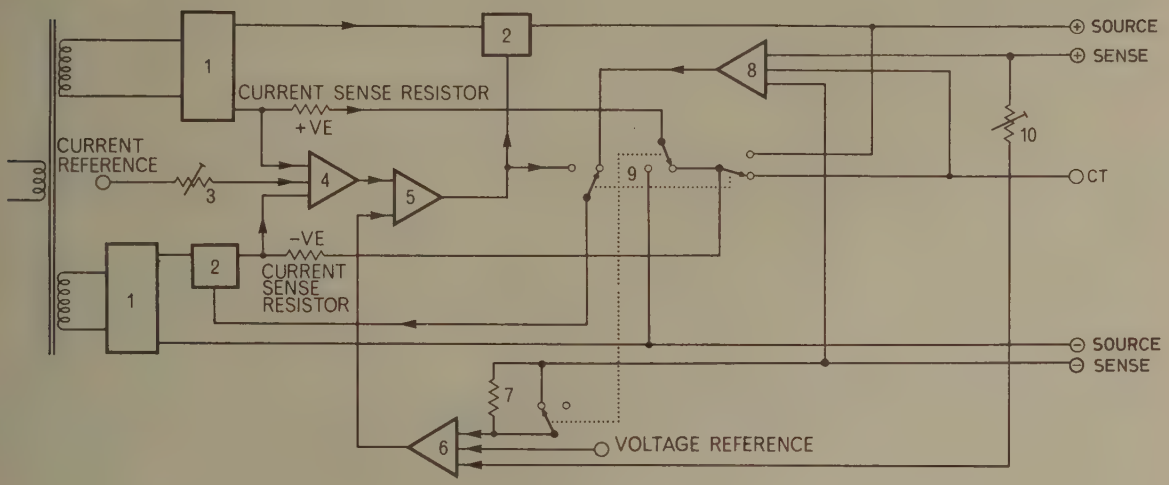


Fig. 3.1 Block Diagram

3.1 INTRODUCTION

The TF 2151 and TF 2152 are identical in function and mechanical layout. The block diagram Fig.3.1 and the following general description Chapter 3.2 is applicable to both instruments.

Each block is numerically coded according to the following table -

1	Rectifier and filter	6	Voltage limit amplifier
2	Series regulator	7	Voltage range resistor
3	Current limit adjust	8	Comparator amplifier
4	Current limit amplifier	9	Mode switch
5	Gate and buffer amplifier	10	Voltage limit adjust

3.2 GENERAL DESCRIPTION

The block diagram shows the principle on which these power supplies operate.

Power is drawn from the a.c. supply through a single transformer with two secondary windings. These supply two rectifier and filter circuits to produce two entirely separate d.c. power sources, each of which feeds a series control element.

In the parallel mode, the output voltage is compared with a fixed reference in the voltage limit amplifier to provide a control signal which is coupled through the gate and buffer amplifier to drive both series control elements.

The constant current supply forms a high dynamic impedance load for the buffer amplifier, ensuring maximum gain from the control loop.

In the series mode, the total output voltage is compared with the fixed reference to provide the control signal for one supply. The outputs of the two supplies are compared in the comparator amplifier to provide a control signal for the second supply.

The current limit amplifier compares the output current with a current reference and when the preset current is reached, takes control of one or both of the series elements, causing the output voltage to fall at constant current as the load resistance falls.

3.3 CIRCUIT DESCRIPTION

The following circuit description should be read with reference to the previous general description, the circuit diagram Fig. 6.1 and to the parts list (Chapter 5). It should be noted that in all respects, other than certain component values, the information relating to TF 2151 is also applicable to the TF 2152.

The a.c. input supply is fused and a single pole ON/OFF switch is fitted in the live side. The transformer has two identical 120 V primary windings tapped at 110 V. These may be connected in parallel or series for operation from line voltages of 110 V, 120 V, 220 V, 230 V and 240 V ±10%, 50-60Hz. Tap changing is done by re-soldering the linking on the transformer primary. A gas-filled indicator lamp is connected across one primary to indicate when the power is switched on.

The transformer has two identical centre-tapped secondary windings, the outputs from which are full-wave rectified to provide the d.c. power sources. A single reservoir capacitor, C1 or C2, is used for each except on the TF2151 which has two capacitors in parallel for each source.

The upper supply on the circuit diagram provides the more positive supply in the series configuration and will be designated supply A, the other being supply B.

The constant current is drawn from supply A through transistor VT104, the base potential of which is referred to supply A positive by the voltage dependent resistor VDR101. The collector of VT104 provides a high impedance, constant current source to the base of VT107.

The series control element consists of an emitter follower which uses two transistors in parallel (supply A - VT401 and VT402; supply B - VT403 and VT404). The series element is driven by a further emitter follower (VT107 or VT109) forming a compound emitter follower with a high current gain.

The voltage reference supply is obtained from the secondary winding of supply B through the half-wave rectifier MR211. It is smoothed by the reservoir capacitor C204 and is initially shunt stabilised by R213 and zener diode MR209. This stabilised voltage feeds the constant current transistor VT209, the base of which is held at constant voltage by zener diode MR212. The resultant stabilised current is applied to the reference zener diode MR213, thus generating a highly stable reference.

The negative reference is compared with the most positive output in a resistor chain consisting of RV1, RV203 and R221 in the parallel mode. In the series mode, RV204 and R222 are connected in parallel with RV203 and R221. The current in this resistor chain is constant, drawn from the reference supply. Thus, as the value of RV1 is varied, the volt drop across it will change, providing the output voltage control.

The signal at the junction of RV1 and RV203 is coupled to the base of VT208, the voltage limit amplifier. The amplifier provides the voltage control signal to the series element of supply A and, in the parallel mode, supply B also, in such a way as to oppose any output voltage fluctuations due to changes in supply voltages or load.

The output of VT208 drives the base of the gating emitter follower VT204 which in turn is coupled to the base of the drive emitter follower VT107 and, in the parallel mode, VT109 also.

The comparator amplifier only operates in the series mode. It consists of an emitter coupled differential amplifier VT102, VT103. The base of VT102 is connected to the centre tap of the two supplies, while the base of VT103 is connected to a resistor chain R108, RV101, R109, connected between the positive and negative outputs. RV101 is preset to exactly balance the two supplies. Any fluctuation in one of the supplies will then generate an unbalance signal which is amplified and coupled to the series element of supply B, to oppose the initial fluctuation. The output of the comparator is taken from the collector of VT103 to the base of VT101, a further amplifier which controls the drive to the base of VT109.

The current reference is drawn through half-wave rectifier MR201 from the transformer winding which provides supply A. Reservoir capacitor C201 provides smoothing and the supply is then shunt stabilised by R201 and zener diode MR202. The supply is further stabilised by R202 and zener diode MR203. This negative supply then provides current to the emitters of VT102 and VT103 and a reference potential to the emitters of VT201, VT202 and the base of VT106.

The current limiting amplifier consists of VT201 and VT202. These are connected as two separate current detectors having similar circuit configurations. VT201 operates on the current in the negative of supply A and provides control in the series and parallel modes. VT202 operates on the current in the positive of supply B and provides control in the series mode only. In the parallel mode, the emitter is elevated to the positive output potential, holding VT202 cut off.

As the circuits are similar, the operation of VT201 will be described. The base of VT201 is connected to a resistor chain consisting of RV2/a, R206 and RV202 across the reference potential. The emitter of VT201 is connected to the current sensing resistor R217. Thus, a proportion of the volt drop across R217, determined by the setting of the current limit control RV2, provides the base emitter signal of VT201. At load currents less than the preset limit, the d.c. bias from RV2 will hold VT201 cut off. At the present limit, however, the emitter of VT201 will move negative with respect to the base and the transistor will conduct. The collector current flows into the base of the gating emitter follower VT203. When VT203 conducts, it draws current from the constant current transistor VT104 and thus starves the base of VT107 and VT109 of current. This causes the output voltage to fall as the voltage limit amplifier cuts off.

The transistor VT106 is normally cut off. It conducts when the current reference supply collapses cutting off the series control elements. This prevents any risk of an output voltage surge when the supply is switched on or off.

Chapter 4

Maintenance & Repair

4.1 INTRODUCTION

This section contains information for keeping the equipment in good working order and for checking its overall performance.

Performance limits quoted are for guidance only and should not be taken as guaranteed performance specification unless they are also quoted in the Data Summary (Chapter 1.2).

In the case of incorrect operation, the location of the faulty component will be greatly simplified by reference to the circuit description (Chapter 3.3) and to the circuit diagram (Fig. 6.1).

In case of difficulty, please write to or phone, the Marconi Instruments Service Division quoting the type and serial number on the rear of the instrument. If the instrument is being returned for repair please indicate clearly the nature of the fault or the work you require to be done.

4.2 ACCESS AND LAYOUT

All pre-set components are mounted on the two printed circuit boards (WO683 and WO684) which are immediately accessible upon the removal of the cover (see Chapter 2.2.2).

The printed circuit boards are each retained by one screw only, thus for fault finding purposes their removal is easily achieved. All components are identified by a clearly marked legend on each board.

CAUTION

After repair work has been carried out on the unit ensure that both the plastic black heat shield on the rear of the unit and the 1/4" P.T.F.E. tube protecting the mains lead are in good repair when re-assembling the unit.

4.3 RE-ALIGNMENT PROCEDURE

The procedure outlined in this section will also constitute a performance check. It is in general applicable to the TF 2152 as well as the TF 2151. Where data is not compatable to both units the TF 2152 figures are given in brackets.

The TF 2670 Multimeter with its Current Shunt Unit 54461-011 or similar multimeter is suitable for all checks except for the final 4 amp check on the TF 2151.

Prepare the instrument for use as outlined in the Operation Procedure (Chapter 2.4) then proceed as follows:-

(i) Connect the voltmeter across the +ve and -ve source output terminals.

To set the Voltage Limit control knob and the Low Voltage Output

(ii) Set Voltage Range switch SW2 to the 15 V (30 V) position.

(iii) Set Voltage Limit fine control RV1b fully counter clockwise.

(iv) Adjust Voltage Limit coarse control RV1a for a 2.5 V (5.0 V) as indicated on the voltmeter.

First releasing the two grub screws, set the Voltage Limit coarse control knob so that the pointer indicates 2.5 V (5.0 V).

(v) Re-set the Voltage Limit coarse control to the 12.5 V (25 V) setting and adjust RV203 (PCB WO683 Legend side) for an output of 12.5 V (25 V) as indicated by the voltmeter.

To adjust the High Voltage Output.

(vi) Without disturbing the setting of the Voltage Limit coarse control set the Voltage Range switch to the 30 V (60 V) position and adjust RV204 (next to RV203) for a 25 V (50 V) output as indicated by the voltmeter.

To adjust the internal meter.

(vii) Set Voltage Limit coarse control for a 30 V (60 V) output as indicated by the voltmeter and adjust RV206 (PCB WO683 track side) until the internal meter also indicates 30 V (60 V).

To adjust the balance of the centre-tap outputs.

(viii) Whilst monitoring the two centre-tap outputs with the voltmeter adjust RV101 (PCB WO684) until the two 15 V (30 V) outputs are within 60 mV of each other i.e. ±15 V ±30 mV (±30 V±30 mV).

(ix) Check linearity of Voltage Limit control calibration meter reading and tracking of centre tap outputs (less than 60 mV).

To set the Current Limit control knob and Output.

(x) Connect a suitable load (e.g. 4 amp 60 ohm rheostat) to CT and ±ve terminal.

(xi) Connect current meter in series with the load and adjust the Current Limit control RV2 from the fully counter clockwise position until current first starts to rise. By releasing the two grub screws set the knob with the pointer at zero.

(xii) Set Current Limit control to the 2A/4A (1A/2A) setting, and adjust RV202 (PCB WO683) until a current output of 1.01 amps is indicated on the current meter.

(xiii) Switch Voltage Range switch to the 15 V (30 V) position. Connect the current meter across the +ve and -ve terminals, set Current Limit control to the 2 amp position. Switch Meter switch SW3 to the +A position and adjust RV205 (PCB WO683) for a correct internal meter reading. Switch Meter switch to the -A position and adjust RV207 for a correct internal meter reading.

The unit is now correctly set up.

4.4 PACKAGING FOR RESHIPMENT

In the event of the equipment being returned for servicing it should be packed in the original shipping carton and packing material. If this is not available wrap the instrument in heavy plastic and place in a rigid box, preferably of wood, fibre board or very strong corrugated cardboard. Use ample soft packing to prevent movement. Provide additional support for projecting parts to relieve these of unnecessary shock. Close the carton securely and seal with durable tape. Mark the shipping container FRAGILE to ensure careful handling.

Chapter 5

Replaceable parts

5.1 INTRODUCTION

This section lists the replaceable parts in alpha-numerical order of circuit references.

Unless otherwise indicated all components are common to the TF 2151 and to the TF 2152.

The following abbreviations are used in the parts list -

C	capacitor	Polest	polyester
C.T.	centre tap	R	resistor
Elect	electrolytic	RV	variable resistor
FS	fuse	SW	switch
FX	ferrite bead	T	transformer
LP	lamp	TL	terminal
M	meter	VDR	voltage dependent resistor
Met Ox	metal oxide	VT	transistor
MR	diode	W.W.	wire wound
Polsty	polystyrene		

5.2 ORDERING

When ordering replacement or spare parts, address the order to our Service Division (for address see rear cover) or nearest representative. Please specify the following information for each part required.

(i) Type and serial number of instrument
(ii) Circuit reference number
(iii) Description
(iv) M.I. part number (preceded by Type Number and FPP) i.e. TF 2151 FPP or TF 2152 FPP ... as applicable.

If a part is not listed, state its function, location and description when ordering.

Spares supplied against M.I. part numbers are electrically interchangeable with those originally fitted, but may not always be identical.

5.3 PARTS LIST

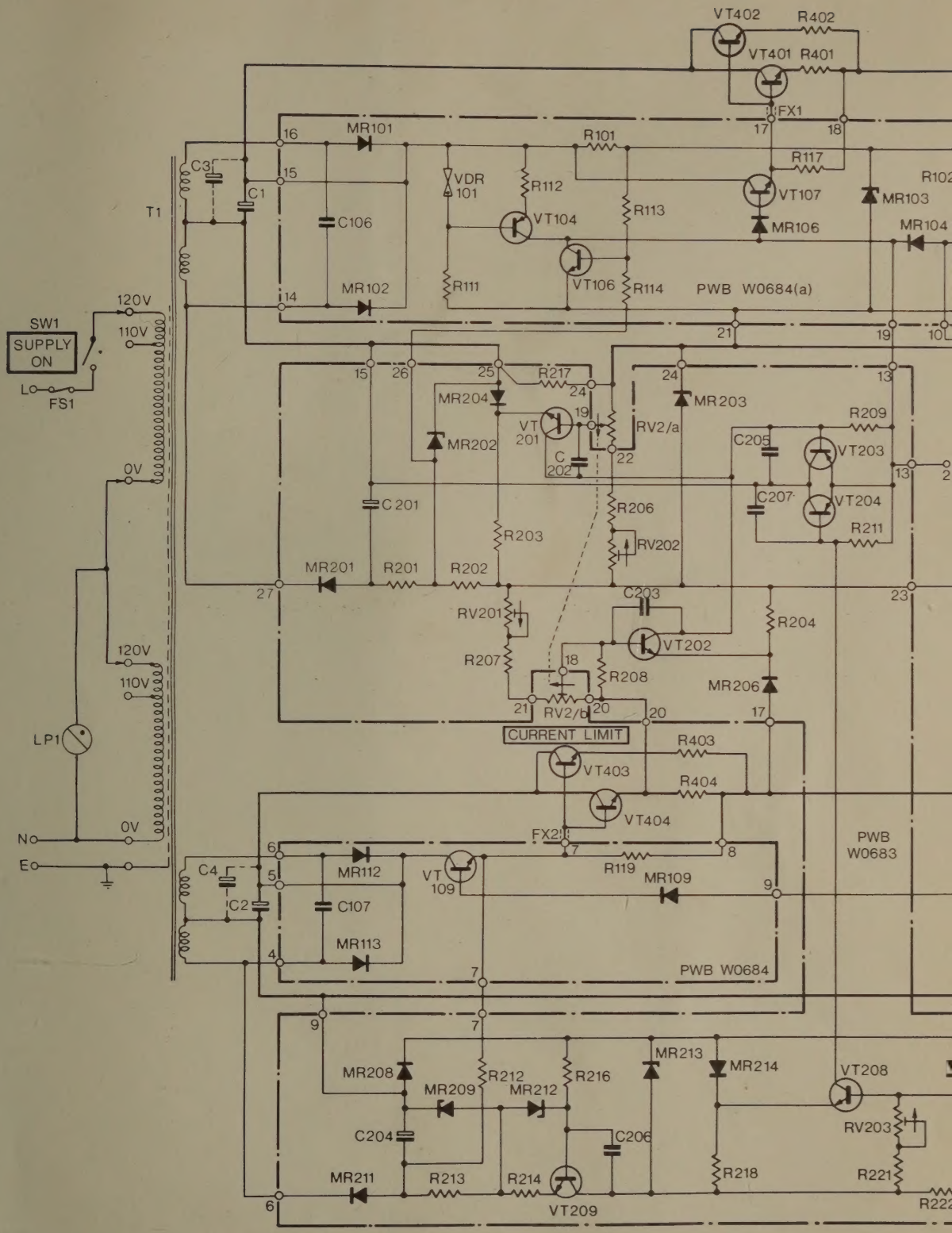
Circuit Reference	Description	M.I.Part No. (TF.....FPP/)
Capacitors		
C1-4 (TF 2151)	4000 µF 40 V Elect	26001
Note - C3/4 Not used if following alternative used on TF 2151		
C1/2 (Alt. TF 2151)	3300 µF 40 V Elect	26010
C1/2 (TF 2152)	2500 µF 64 V Elect	26009
C1/2 (Alt. TF 2152)	1500 µF 63 V Elect	26011
C5/6	250 µF 64 V Elect	26002
C101	1000 pF ±20% 63 V Polsty	26003
C102	10 µF +50 -10% 70 V Elect	26004
C103/4	64 µF +50 -10% 64 V Elect	26005
C106/7	0.022 µF ±20% 100 V Polest	26006
C108	6800 pF ±10% 200 V Filmite	26007
C201/204	250 µF 64 V Elect	26002
C202/203/205	82 µF ±20% 63 V Polsty	26008
C206	0.022 µF ±20% 100 V Polest	26006
C207	1000 pF ±20% 63 V Polsty	26003
Fuses -		
FS1	3 Amp Fuse 20 x 5 mm	23402
	Fuse Holder	23401
Ferrite Beads -		
FX1/2	Ferrite Bead FX1115	23635-833
Lamps -		
LP1	Neon 110/115 V	23701
Meter -		
M1 (TF 2151)	0-1 mA FSD (DWG W 0716)	44501
M1 (TF 2152)	0-1 mA FSD (DWG W 0715)	44503
Diodes -		
MR101/102, 108,111-113	3A400 Solidev	28101
MR103	BZY88 C9V1 Zener Mullard	28371-753
MR104-107, 109,110	482 - 2 Weir Spec.	28336-676
MR201,210/211	BYX36 - 300 Mullard	28357-028
MR202	BZY88 C9V1 Zener Mullard	28371-753
MR203,213	BZY88 C5V6 Zener Mullard	28371-434
MR204,206	OA200 Mullard	28337-534
MR205,208,214	482 - 2 Weir Spec.	28336-676
MR209	BZY88 C15 Mullard	28372-303
MR212	BZY88 C4V7 Mullard	28371-434

Circuit Reference	Description	M.I.Part No. (TF.....FPP/)
Resistors -		
R101	1.8 k 5% 2½ W W.W.	25123-086
R102	2.7 k 5% ½ W Met Ox	24552-092
R103	1.0 k 5% ½ W Met Ox	24552-080
R104	22 k 5% ½ W Met Ox	24552-118
R106	15 k 5% ½ W Met Ox	24552-
R118,122	10 k 5% ½ W Met Ox	24552-110
R108,109,114	3.3 k 5% ½ W Met Ox	24552-094
R111	18 k 5% ½ W Met Ox	24552-116
R112	180 5% ½ W Met Ox	24552-056
R113	3.9 k 5% ½ W Met Ox	24552-096
R117,119	100 5% ½ W Met Ox	24552-050
*R201	1.2 k 5% 2½ W W.W.	25123-080
R202	470 5% ½ W Met Ox	24552-069
R203/204,208	27 k 5% ½ W Met Ox	24552-120
R206/207	22 k 5% ½ W Met Ox	24552-118
R209	18 k 5% ½ W Met Ox	24552-116
R211,221,222	1.8 k 5% ½ W Met Ox	24552-086
R212	33 k 5% ½ W Met Ox	24552-122
R213	820 5% 2½ W W.W.	24001
R214	270 5% ½ W Met Ox	24552-061
R216	3.3 k 5% ½ W Met Ox	24552-094
*R217 (TF 2151 2 off)	1.2 5% 2½ W W.W.	24002
*R217 (TF 2152)	1.2 5% 2½ W W.W.	24002
R218	2.7 k 5% ½ W Met Ox	24552-092
*R219/220	0.1 5% 2½ W W.W.	24003
R223,225	330 5% ½ W Met Ox	24552-063
R224	27 k 5% ½ W Met Ox	24552-120
R401-404 (TF 2151)	1.2 5% 2½ W W.W.	24002
R401-404 (TF 2152)	2.2 5% 2½ W W.W.	24005

*Ensure that these components are fitted with insulating beads.

Variable Resistors		
RV1a) (TF 2151) RV1b)	6 k/250 10% 2W + 2W Dual Concentric (Voltage Limit coarse/fine)	25001
RV1a) (TF 2152) RV1b)	12 k/500 10% 2W + 2W Dual Concentric (Voltage Limit coarse/fine)	25008
RV2	10 k/10 k 1W Lin (Current Limit)	25002
RV101	470 Morganite 62V	25003
RV201/202	22 k Morganite 62V	25004
RV203/204	1 k Morganite 62V	25005
RV205,207	100 k Morganite 62H	25006
RV206	10 k Morganite 62H	25007

Circuit Reference	Description	M.I.Part No. (TF....FPP/)
Switches -		
SW1	SPST (Mains ON/OFF)	23004
SW2	4 pole c/o (Voltage Range)	23005
SW3	2P3W (Meter Range)	23006
Transformer -		
T1 (TF 2151)	Mains MEP/TEL10 (WO 0709)	44502
T1 (TF 2152)	Mains MEP/TEL10 (WO 0708)	44504
Terminals -		
TL1/2	SOURCE, SENSE +ve (RED)	23007
TL3	C.T. (BLUE)	23008
TL4/5	SOURCE, SENSE -ve (BLACK)	23009
Voltage Dependent Resistor		
VDR1	Mullard E295ZZ/02	24004
Transistors -		
VT101-103,106	BC107 Mullard	28455-437
VT104	BFX29 Mullard	28435-867
VT107,109	NKT0039 Newmarket	28202
VT201/202,209	BC107 Mullard	28455-437
VT203/204	BCY70 Mullard	28434-853
VT208	BFY50 Mullard	28456-777
VT401-404	2N3055 Mullard	28456-567


VT402
R402
VT401
R401
FX1
MR101
R101
R117
VDR 101
R112
VT107
MR103
C3
C1
T1
C106
VT104
R113
MR106
MR104
MR102
R111
VT106
R114
PWB W0684(a)
120V
110V
SW1
SUPPLY ON
L
FS1
0V
MR204
R217
MR203
R209
MR202
VT 201
RV2/a
C205
VT203
C 202
C207
VT204
C 201
R206
R211
R203
RV202
MR201
R201
R202
C203
RV201
R204
VT202
R207
R208
MR206
RV2/b
CURRENT LIMIT
R403
VT403
R404
VT404
LP1
N
E
FX2
PWB W0683
C4
C2
MR112
VT 109
R119
MR109
C107
MR113
PWB W0684
MR208
MR209
R212
MR212
R216
MR213
MR214
VT208
C204
C206
RV203
MR211
R213
R214
R218
R221
VT209

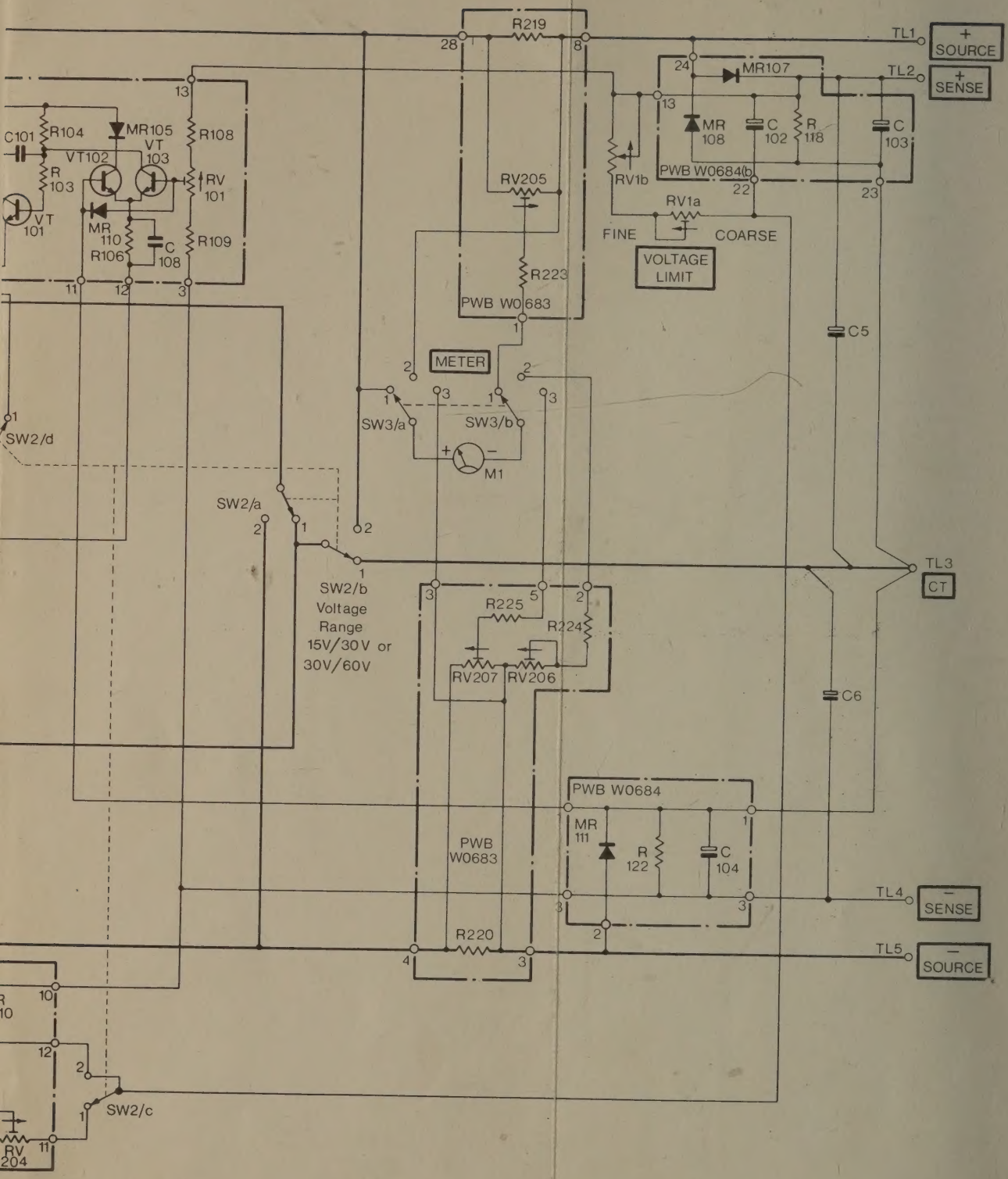


Fig. 6.1 TF 2151 & TF 2152 CIRCUIT DIAGRAM

TF 2151 & 2152

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